in the form of a rosette of cells encysted near the upper extremity of the intestine. The rosette is at first single, but shortly takes the appearance of a double ring, the rings being united by a curved tube. These rings seem to represent the rudiments of the ambulacral vascular system of the echinoderm, and the curved tube the origin of the alimentary canal. A dense coating of granular areolar tissue is formed round the young crinoid, obscuring the further development of the internal organs. The mode of its disengagement from the larva was not observed.

Free from the locomotive larva, the echinoderm in its earliest stage is a motionless, white, egg-like body, covered externally with a thick transparent layer, which is traversed vertically by scattered fusiform oil-cells.

Beneath this layer are seen rapidly-forming patches of the calcified areolar tissue so characteristic of the class. The body becomes club-shaped; the narrow end attaches itself by cement-matter to some foreign substance, and a head and stem are distinguished.

Two corresponding rows of five plates each (the *basalia*, and the first row of the *interradialia*) form a calcareous chalice round the base of the head. Rudimentary arms now first make their appearance, and the development of the attached pentacrinal form proceeds steadily.

From his observations of several broods during the spring of 1858, the author was led to believe that, under circumstances favourable to the production of the pentacrinal stage, the development of the larva may be arrested in any of its earlier stages, and before the complete differentiation of its internal organs. It is hoped that the observations of another season may solve this and other questions which still remain somewhat obscure.

II. "On the Stratifications in Electrical Discharges, as observed in Torricellian and other Vacua."—Second Communication. By J. P. Gassiot, Esq., V.P.R.S.

(Abstract.)

The author of this Paper states that he procured several vacuum-tubes from M. Geissler of Bonn, and alludes to the experiments

made in similarly constructed tubes by M. Plücker (Phil. Mag. August 1858), but finding it impracticable to ascertain with accuracy the nature of the residual gas, he reluctantly laid them aside. All the vacuum-tubes in which his experiments were made, were prepared by himself or in his presence; as each was exhausted and hermetically sealed, it was marked with a consecutive number; upwards of 100 were thus prepared; many were broken or otherwise destroyed, but the remainder he retains with the original numbers for future reference. The author uses several terms, which he explains: air, hydrogen, oxygen, or nitrogen (mercurial) denote that the vacuum-tube contains vapour of mercury *plus* the air or gas remaining in the tube with which it was filled previous to the introduction of the mercury: he applies the terms outer positive or negative, and inner positive or negative, to denote the character of the discharge from the terminals; conductive and reciprocating denote the peculiar conditions of discharges from an induction apparatus when taken in vacuum-tubes; with a conductive discharge the needle of a galvanometer placed in the circuit will be deflected, as are also the stratifications on the approach of a magnet—they having, as the author has shown in his former communication, a tendency to rotate as a whole round either pole, but in contrary directions; in a reciprocating discharge the stratifications are confused, they are divided or separated by the magnet, and the needle of a galvanometer placed in the circuit is not deflected.

The author explains the condition which the stratified discharge assumes if any air or gas remains or is subsequently introduced into a Torricellian vacuum, and describes what he denominates a white and a blue tongue discharge, which under certain conditions always appears at the negative terminal. In Torricellian vacua, if air or nitrogen is introduced, the stratifications, exclusive of their altered form, exhibit a red colour, while when hydrogen or oxygen is added, they retain the bluish-grey appearance: when the ends of the tubes were punctured by means of an electrical spark from a machine, the air or gas could be admitted so gradually as to occupy two or three hours in the experiment, and in this manner the preceding results were obtained.

In the best Torricellian vacua the author has been able to obtain, the stratifications always assumed a long cloud-like appearance; by

using ten cells, he on one occasion observed distinct sets of stratifications, one from each terminal, in opposite directions.

From a variety of experiments made in the laboratory of the Royal Institution in temperatures varying from $-102°$ to upwards of $+600°$ Fahr., he obtained the following results:—

When the flame of a spirit-lamp is applied to the discharge in a vacuum-tube, the stratifications, if they are narrow, will become clearer and divided, attaching themselves to the warmer portion of the tube; if a section of the tube is heated, the stratifications in that section will be more separated, becoming closer in the cooler portion.

If heat is applied to a tube which shows the cloud-like stratifications, they will lose their clear distinctness; the deposit from the negative wire appears to be more free, and distinct sparks or discharges are apparent, but none from the positive.

In a Torricellian vacuum from which the mercury was withdrawn, which gave clear cloud-like stratifications, no change could be observed when the temperature was lowered to $+32°$ Fahr.; at a temperature of $-102°$, all trace of the stratified discharge was destroyed, and in this state the red or heated appearance of the negative wire disappeared, the discharge filling the entire vacuum with a white luminous glow; on the temperature being raised the stratifications reappear. When the mercury in a Torricellian vacuum is boiled, indicating a heat of upwards of $+600°$, the stratifications are also destroyed; but in this case the mercury as it condenses carries the discharge, becoming a conductor.

When the mercury is frozen the stratifications disappear, and the discharge did not then illuminate the entire length of the tube; on presenting a magnet near the tube, the cloud-like stratifications immediately reappear from the positive terminal, very distinct, but not so clearly separated as when the tube is in its normal state of temperature.

The author being desirous to obtain vacua free from all trace of the vapour of mercury, endeavoured to do so by means of fusible metal, but traces of air were perceptible; he also prepared apparatus for a tin vacuum: in a vacuum obtained by means of oxygen and sodium, very good stratifications were observable. At the suggestion and with the assistance of Dr. Frankland, vacua were obtained by absorbing rarefied carbonic acid by means of caustic potassa. This process is described, and a drawing of the apparatus is given.

In carbonic acid vacua the discharge at first appears in the form of a wavy line; it is strongly affected on the approach of a magnet or by the hand, but does not generally present the stratified appearance; if this be present, it is only near the positive terminal: sometimes in the course of a few minutes, but often not until after several days, stratifications are visible, which, as the carbonic acid becomes absorbed, increase; they subsequently assume a conical form, and lastly, the clear cloud-like character of the best Torricellian vacua. Under certain conditions the stratifications disappear, the whole length of the tube being filled with luminosity; when in this state, if the outside of the tube is touched, pungent sparks can be perceived $\frac{1}{8}$th of an inch in length, and the peculiar blue phosphorescent light, that in the ordinary state is perceptible at the negative, is perceptible at both terminals, and a galvanometer shows that the discharge is no longer conductive.

After noticing the difficulty of obtaining in carbonic acid vacuum-tubes precisely the same results, the author describes one experiment in which moisture was purposely introduced; in this tube the stratified discharge was very clear and distinct. He states (and describes the illustrative experiment) that under certain conditions the stratifications entirely disappear, the vacuum insulating the discharge. Carbonic acid vacuum-tubes were prepared, into which *arsenious acid*, *iodine*, *bromine*, *pentachloride of antimony*, *bichloride* and *bisulphide of carbon* were severally introduced, and the results obtained are described.

In Torricellian vacua the author was necessarily limited in the size of the glass vessels employed, but with carbonic acid this difficulty no longer exists; in one vessel of 7 inches internal diameter, the stratified discharge was observed to fill the entire space; in another, the discharges were made to pass in the middle of the vessel through a small hole in the centre of a glass diaphragm.

After many trials, the author ascertained that if the negative terminal is covered with glass tubing (open at each end) to about $\frac{1}{8}$th of an inch beyond the terminal of the wire, the stratifications are destroyed. In this state the negative discharge appears to issue with considerable force through the orifice; this discharge can be deflected by the magnet, and wherever it impinges, a brilliant blue phosphorescent spot is perceivable, which spot is in a short time sensibly heated. The author remarks that in this experiment there

is the *appearance of a direction of a force emanating from the negative.*

In some of the vacuum-tubes beyond the clear cloud-like stratifications, but nearer the negative terminal, several faint striæ can be obtained: on repeating Mr. Grove's experiment (Phil. Mag. July 1858), of allowing the discharge to pass between two metallic points attached to the coil, the author observed that these faint striæ *invariably* disappeared.

Stratifications remarkably sensitive to induction on the approach of the hand were obtained in a glass cylinder of about 4½ inches diameter, in which the wires were hermetically sealed 21 inches apart.

From the absorption of carbonic acid by caustic potassa, not only were vacua obtained far more perfect than by the Torricellian method, but the process can be made so gradual as to occupy several weeks, or even months, thus enabling the experimenter to examine the phenomena of the stratified discharge under a variety of conditions, several of which the author describes; in this manner the *non-transferring condition for the electrical discharge in a vacuum has been experimentally ascertained.* The author considers that this confirms the opinion he ventured to offer in his previous paper; for if the pulsations or vibrations of an electrical discharge are greatest in the bright bands and least in the obscure, this system of interference or of pulsations would also account for the entire absence of stratifications when the air or gas is not sufficiently rarefied, as well as when the vacuum becomes nearly perfect, while the gradual change of narrow to cloud-like stratifications is thus satisfactorily explained.

In an additional note to his Paper, the author describes some further experiments, particularly one of moving the vacuum-tube to and fro in a rapid manner, or rotating it in a plane, while the discharges are made, either singly or continuously: in the latter case the stratified discharges are separated, giving the appearance of an illuminated fan or wheel; in the former, only a single discharge is perceptible, taking place in whatever direction the tube may at the instant be placed. The author considers this experiment as confirmatory of his former opinion, that the stratifications *are entirely due to a single disruption of the primary circuit.*

The experiments, as described in the Paper, were exhibited by the author to the Society.